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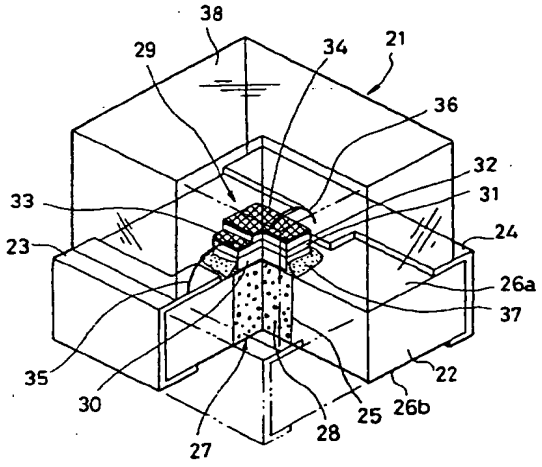
(54) LIGHT-EMITTING DIODE

(57) A light emitting diode 21 in which a through hole 25 is provided in a glass epoxy substrate 22 which extends from the upper surface 26a to the lower surface 26b thereof, a transparent resin section 27 is used to fill the through hole 25, a light emitting diode element 29 made of a gallium nitride based compound semiconductor with a transparent element substrate of sapphire glass 30 is fixed on top of the transparent resin section 27 using a transparent adhesive 37, and light blocking electrodes 33, 34 are provided on the upper surface of the light emitting diode element 29, and light emitted from the light emitting diode element 29 passes through the transparent resin section 27 and is guided out through a bottom surface 26b of the glass epoxy substrate 22. When the light emitting diode 21 is mounted onto a motherboard 41, by dropping the resin sealing body 38 of the light emitting diode 21 down into an insertion hole 42 formed in the motherboard 41, the height dimension of the mounted light emitting diode 21 mounted can be reduced.

Fig.1



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tom surface of the base material is condensed, improving the light emission intensity another level.

[0015] Furthermore, in a light emitting diode according to yet another aspect of the present invention, the aforementioned base material is any one of a glass epoxy substrate, a transparent resin substrate and a transparent glass substrate.

[0016] According to this invention, by making the light emitted from the light emitting diode element passes through the transparent glass substrate side which is less likely to deteriorate on exposure to ultraviolet light, light emission of a good intensity level can be maintained even after prolonged use.

[0017] Furthermore, in a light emitting diode according to yet another aspect of the present invention, the aforementioned non-transparent section provided above the light emitting diode element is either one of a pair of light blocking electrodes provided on the upper surface of the light emitting diode element, and a reflective film covering the outer surface of the transparent resin sealing body.

[0018] According to this invention, light emitted from the light emitting diode element is guided efficiently through the lower surface of the base material.

[0019] Furthermore, in a light emitting diode according to yet another aspect of the present invention, when the light emitting diode is mounted on a motherboard, the light emitting diode is mounted upside down with the resin sealing body dropping into a hole provided in the motherboard, and the periphery sections of this hole connect the external connection electrodes of the light emitting diode with the wiring pattern of the motherboard.

[0020] According to this invention, when the light emitting diode is mounted upside down on the motherboard, by soldering the aforementioned external connection electrodes to the wiring pattern on the motherboard, current can be carried to the light emitting diode element, and so the mounting operation is extremely simple. Furthermore, the height dimension by which the light emitting diode protrudes from the motherboard can be reduced dramatically.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

FIG. 1 is a perspective view showing a first embodiment of a light emitting diode according to the present invention;

FIG. 2 is a cross-sectional view showing the light emitting diode of FIG. 1 mounted onto a motherboard;

FIG. 3 is a cross-sectional view similar to FIG. 2, showing a second embodiment of a light emitting diode according to the present invention;

FIG. 4 is a cross-sectional view similar to FIG. 2, showing a third embodiment of a light emitting diode according to the present invention;

FIG. 5 is a cross-sectional view similar to FIG. 2, showing a fourth embodiment of a light emitting diode according to the present invention;

FIG. 6 is a cross-sectional view similar to FIG. 2, showing a fifth embodiment of a light emitting diode according to the present invention;

FIG. 7 is a perspective view showing a sixth embodiment of a light emitting diode according to the present invention;

FIG. 8 is a cross-sectional view showing the light emitting diode of FIG. 7 mounted onto a motherboard;

FIG. 9 is a cross-sectional view similar to FIG. 8, showing a seventh embodiment of a light emitting diode according to the present invention;

FIG. 10 is a cross-sectional view similar to FIG. 8, showing an eighth embodiment of a light emitting diode according to the present invention; and

FIG. 11 is a cross-sectional view showing a conventional light emitting diode mounted onto a motherboard.

BEST MODE FOR CARRYING OUT THE INVENTION

[0022] Light emitting diodes of the present invention will be described below in further detail with reference to the appended drawings.

[0023] FIG. 1 and FIG. 2 are diagrams showing a first embodiment of a surface mounted light emitting diode. In the surface mounted light emitting diode 21 according to this embodiment, a pair of external connection electrodes (a cathode electrode 23 and an anode electrode 24) are formed by patterning on the upper surface of a rectangular glass epoxy substrate 22 which serves as a base material, and a through hole 25 with a square shaped cross section is provided in the central area of the glass epoxy substrate 22 and passes from the upper surface 26a thereof through to the lower surface 26b. This through hole 25 is filled with a transparent resin, forming a transparent resin section 27 which is substantially level with the upper surface 26a and the lower surface 26b of the glass epoxy substrate 22. In this embodiment, a fluorescent material 28 comprising an yttrium compound or the like is dispersed within the transparent resin section 27, and converts blue light into white light through a wavelength conversion described below.

[0024] A light emitting diode element 29 is installed on the upper surface 26a of the aforementioned glass epoxy substrate 22, substantially directly above the transparent resin section 27. This light emitting diode element 29 is a blue colored light emitting element made from a gallium nitride based compound semiconductor, and has a structure in which an n-type semiconductor 31 and a p-type semiconductor 32 are grown on the upper surface of a sapphire substrate 30 of transparent glass. Electrodes are provided on the respective upper surfaces of both the n-type semiconductor 31 and the

transparent resin substrate 47 with a transparent adhesive 37, and the upper surface of the light emitting diode element 29 is protected by a transparent resin sealing body 38. The light emitting diode element 29 is mounted upside down onto the motherboard 41, and irradiates light upward from the motherboard 41, in the same manner as the previous embodiments. In this third embodiment, the entire transparent resin substrate 47 comprises the transparent body, and so the device is applicable to wide range irradiation. However, as with the previous embodiment, in those cases where an improved directivity and convergence is required, a hemispherical lens section could also be provided at the lower surface 26b of the transparent resin substrate 47, or a fluorescent material dispersed within the transparent adhesive.

[0033] FIG. 5 is a diagram showing a fourth embodiment of the present invention. In a light emitting diode 21 according to this embodiment, the base material is composed of a transparent glass substrate 50, and a cathode electrode 23 and an anode electrode 24 are patterned on the transparent glass substrate 50 using a technique such as vapor deposition or etching. As with the previous embodiments, a light emitting diode element 29 comprising a gallium nitride based compound semiconductor is fixed with a transparent adhesive 37 to the transparent glass substrate 50 which serves as the transparent body, and the upper surface of the light emitting diode element 29 is protected by a transparent resin sealing body 38. However, in this fourth embodiment, a fluorescent material 28 has been dispersed within the transparent adhesive 37.

[0034] In the same manner as the previous embodiments, during mounting onto a motherboard 41, the light emitting diode 21 is fixed upside down, with the resin sealing body 38 dropping into an insertion hole 42 formed in the motherboard 41. As a result, light irradiates upward from the motherboard 41. The aforementioned wavelength conversion occurs within the transparent adhesive 37 comprising the dispersed fluorescent material 28, with the converted light passing straight out through the transparent glass substrate 50, and so a highly reliable white light emission of good intensity can be obtained over prolonged periods.

[0035] FIG. 6 is a diagram showing a fifth embodiment of the present invention. In this embodiment, a pair of electrodes 33a, 34a are provided partially covering the upper surface of a light emitting diode element 29 comprising a gallium nitride based compound semiconductor, and a resin sealing body 38a for sealing the light emitting diode element 29 is formed in a dome shape. The outer surface of the resin sealing body 38a is coated with a reflective film 48. In the same manner as the third embodiment, the base material is formed from a transparent resin substrate 47 with a fluorescent material 28 dispersed therein. The pair of electrodes 33a, 34a need not necessarily be non-transparent. The resin sealing body 38a is formed from a transparent resin material, and the reflective film 48 is formed by vapor deposition of silver or aluminum or the like.

[0036] Consequently in this embodiment, because the electrodes 33a, 34a are only partially formed, light emitted from the light emitting diode element 29 in the direction of the resin sealing body 38a, passes into the resin sealing body 38a and is reflected by the reflective film 48. At this point, the reflective film 48 functions like a concave lens, converting the reflected light into a parallel light beam 49 which passes through the transparent resin substrate 47. During this passage through the transparent resin substrate 47, the light excites the fluorescent material 28 dispersed within the transparent resin substrate 47 and undergoes a wavelength conversion.

[0037] Moreover, the light blocking electrodes 33, 34 provided on the upper surface of the light emitting diode element 29 in each of the first embodiment through to the fourth embodiment could also be limited to partially formed electrodes. In such cases, light emission can be guided towards the lower surface 26b of the glass epoxy substrate 22 by forming the resin sealing body 38 of a non-transparent resin, thereby blocking the transmission of light, or by providing a reflective film on the outer surface of the resin sealing body 38 in the same manner as the fifth embodiment. The shape of the resin sealing body in those cases where a reflective film is provided thereon, may be either rectangular or dome shaped.

[0038] FIG. 7 and FIG. 8 are diagrams showing a sixth embodiment of the present invention. A light emitting diode 21 according to this embodiment comprises a square shaped transparent glass substrate 50, a frame 51 on which are formed external connection electrodes 53, 54 at the left and the right sides of the transparent glass substrate 50, and a light emitting diode element 29 installed in the center of the upper surface of the transparent glass substrate 50. The transparent glass substrate 50, which functions as a transparent body, uses typical colorless, transparent glass.

[0039] In the same manner as the previous embodiments, the light emitting diode element 29 is a blue light emitting element comprising a gallium nitride based compound semiconductor in which an n-type semiconductor 31 and a p-type semiconductor 32 have been grown on the upper surface of a sapphire substrate 30. Non-transparent light blocking electrodes 33, 34 are formed on the upper surface of the light emitting diode element 29.

[0040] The light emitting diode element 29 is fixed to the upper surface of the transparent glass substrate 50 by a thick application of a transparent adhesive 37. A fluorescent material 28 comprising an yttrium compound or the like is dispersed within the transparent adhesive 37, and is able to convert the blue light emitted from the light emitting diode 21 to visible light of a longer wavelength.

[0041] The external connection electrodes 53, 54 are formed on the square shaped plastic frame 51 which covers the outer periphery of the upper surface of the

sealing body of light emitting diode down into a hole formed in the motherboard the overall height dimension of the light emitting diode, including the thickness of the motherboard, can be reduced to a value smaller than conventional surface mounted devices, enabling the manufacture of thinner devices.

[0051] Furthermore, in a light emitting diode according to the present invention light is emitted out through the base material, and so deterioration of the resin sealing body due to ultraviolet light is prevented. Consequently, a highly reliable device can be provided in which any decrease in light intensity is suppressed, even with continued use over prolonged periods.

Claims

1. A light emitting diode prepared by mounting a light emitting diode element on an upper surface of a base material and protecting said light emitting diode element with a resin sealing body, wherein a transparent body is provided in said base material which extends from the upper surface through to a lower surface thereof, a light emitting diode element comprising a gallium nitride based compound semiconductor with a transparent element substrate is fixed on top of said transparent body with a transparent adhesive, a non-transparent section is provided above said light emitting diode element, and light emitted from said light emitting diode element passes through said transparent body to be guided out through the lower surface of said base material.

2. The light emitting diode according to claim 1, wherein a through hole is provided in said base material which extends from the upper surface through to the lower surface thereof, and said transparent body is formed by filling said through hole with a transparent resin.

3. The light emitting diode according to claim 1, wherein a fluorescent material comprising an yttrium compound is dispersed and mixed into at least one of said transparent body and said transparent adhesive.

4. The light emitting diode according to claim 1, wherein a condenser lens section is provided on said lower surface of said base material, below said transparent body.

5. The light emitting diode according to claim 1, wherein said base material is any one of a glass epoxy substrate, a transparent resin substrate and a transparent glass substrate.

6. The light emitting diode according to claim 1, wherein said non-transparent section provided above said light emitting diode element is a pair of light blocking electrodes provided on an upper surface of said light emitting diode element.

7. The light emitting diode according to claim 1, wherein said non-transparent section provided above said light emitting diode element is a reflective film covering an outer surface of said transparent resin sealing body.

8. A light emitting diode, wherein when the light emitting diode according to claim 1 is mounted on a motherboard, said light emitting diode is mounted upside down, with said resin sealing body dropping into a hole provided in said motherboard, and periphery sections of said hole connecting external connection electrodes of said light emitting diode with a wiring pattern of said motherboard.

Fig.2

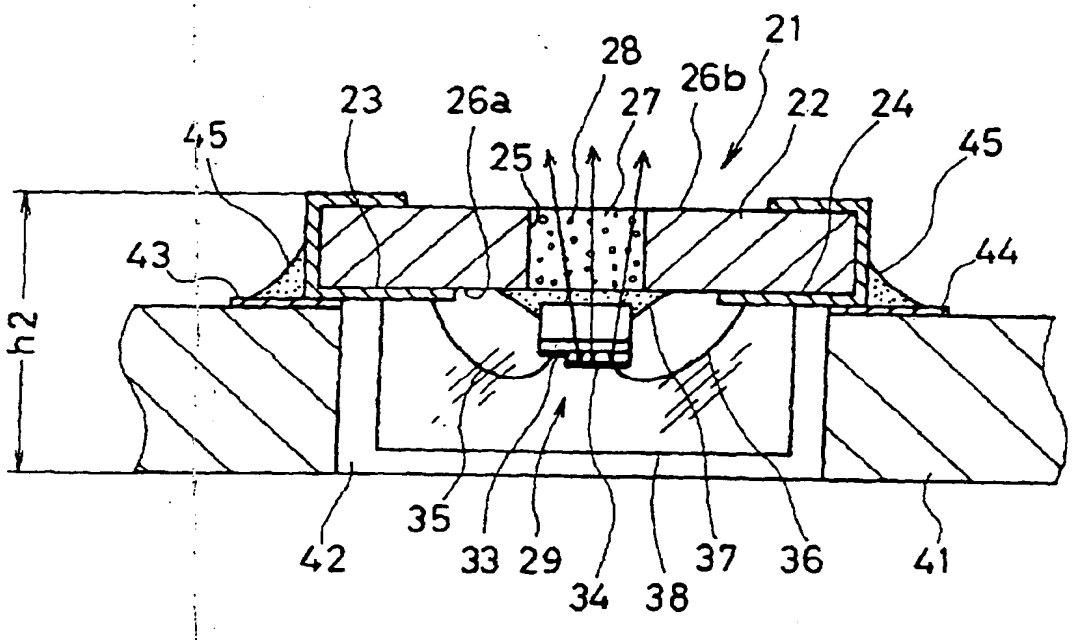


Fig.5

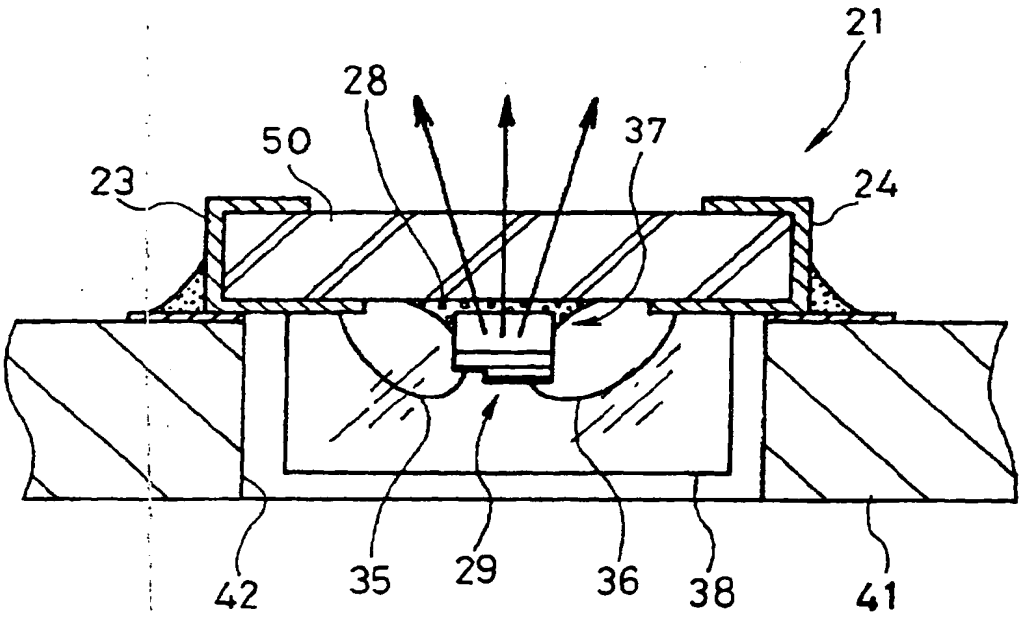


Fig.7

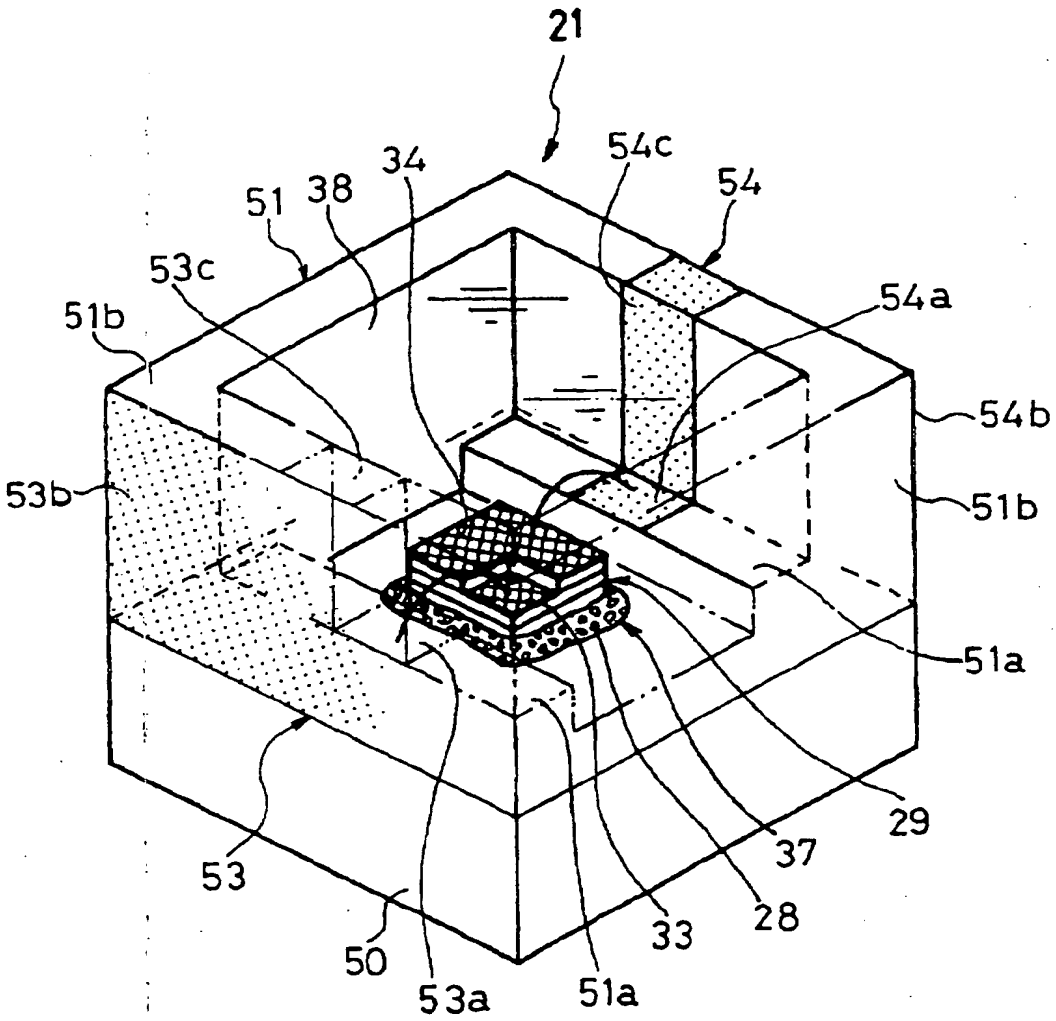


Fig.9

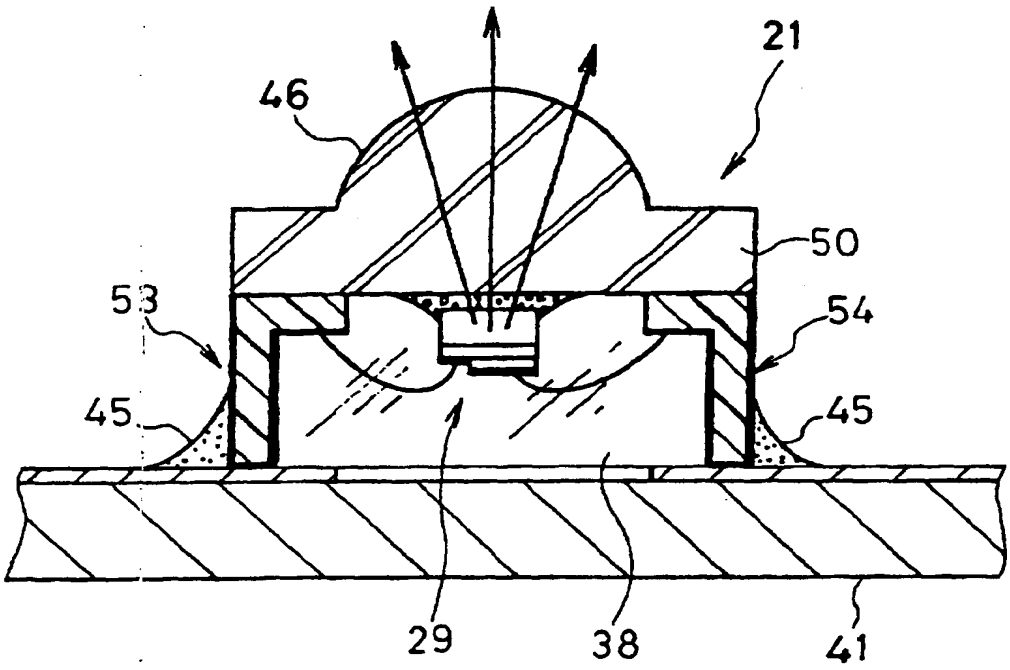
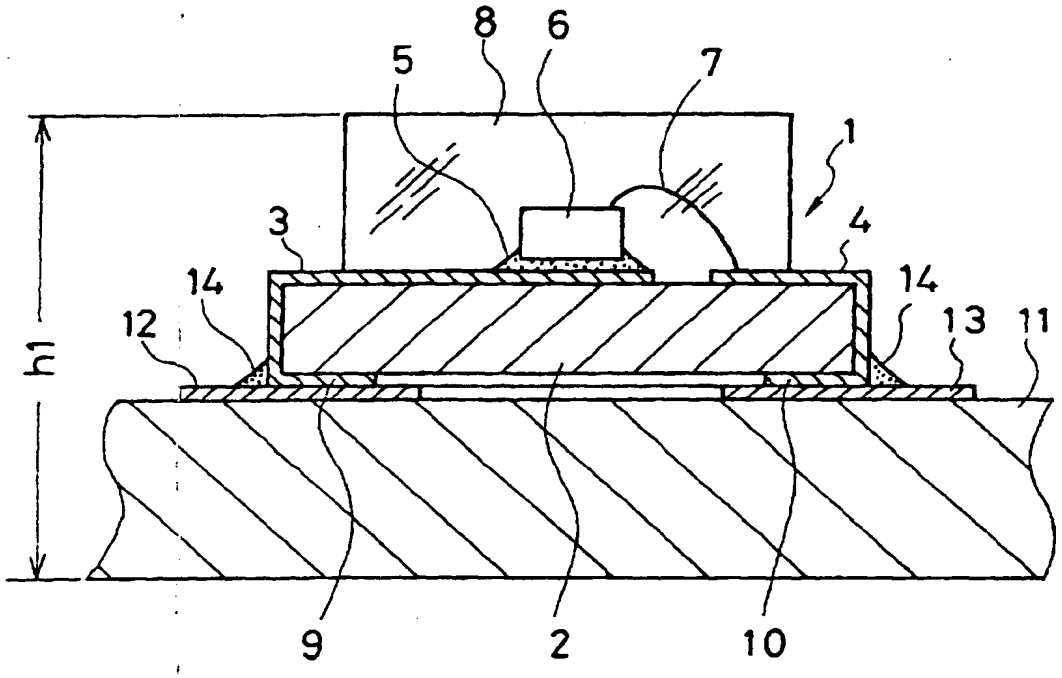


Fig. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/05038

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 11-186590, A (Rohm Co., Ltd.), 09 July, 1999 (09.07.99), Fig. 8 (Family: none)	8

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